INTERNATIONALLY MONITORED RETRIEVABLE STORAGE SYSTEMS

A step toward world peace in the nuclear age

Chauncey Starr*
President Emeritus, EPRI

Wolf Hafele*
Director (ret.) Rossendorf/Germany

March 7, 2000
East Asia Seminar/LLNL, Las Vegas, Nevada, US

I. Introduction: For the past five years, we have been proposing at meetings and workshops an international approach to the peacetime management of spent fuel from nuclear power plants. At this meeting, we will discuss various versions of such an approach. They all share many objectives and issues. We will discuss in this paper some of this commonality.

II. Objectives: We need to clarify the several societal, political, and international end-purposes of spent fuel management, and to recognize the differing priorities among various public sectors and governments. The three encompassing concerns are people's physical security and their environment, national security, and economic energy supply. The following specific targets for spent fuel management have been emphasized in past workshops and professional meetings.

1. Public health protection from harmful radiation exposure levels.

2. Avoid weapons Pu extraction from the civilian fuel cycle.

3. Create public confidence that the above risks are avoided.

4. Provide an operational closure to the nuclear fuel cycle.

5. Minimize the environmental "footprint" of these activities.

6. Minimize social costs of the fuel cycle back-end.

These objectives are key both for managing spent fuel and for supporting the continued growth of nuclear power. Regardless of nuclear power's trends, the global spent fuel accumulation will grow in the coming decades, and may become a serious hazard if left to ad-hoc and quick "fixes" worldwide.

II. Planning Constraints:

We need to acknowledge the non-technical "walls-of-worry" bounding spent fuel management proposals in today's political world. This is our list and priorities. National political realities may suggest adjustments.

1. Fear of the health effects of radiation.

2. The security threat from declared non-weapons states with possibly secret programs (e.g. N. Korea; Iraq; Iran)

3. The security threat from sophisticated terrorist groups.

4. Public distrust of the quick "fixes" of political decision-makers.

5. Public suspicion of manipulation by official media.

6. The confusing guidance from multi-agency regulations.

7. The absence of sufficient scientific, technical, or operating experience to provide long-term confidence in today's spent fuel-handling alternatives.

8. The very long lead-time (several political cycles) and high construction cost of proposed spent fuel disposal systems.

9. The absence of a credible basis for estimating the total construction costs, operating costs, and social costs of any system.

10. Bureaucratic delays in issuing performance criteria.

11. Doctrinaire opposition of some anti-nuclear and anti-establishment organizations.

III. The Near Term Need For Storage:

It is evident from items 7-10 of the above list that it will be many decades before publicly acceptable closures to the fuel cycle are demonstrated and proven to meet societal objectives, i.e. reach the stage of being either commercial or industrially routine installations. We will not here explore in depth the comparative merits of permanent geologic storage and of the breeder recycle. We believe they are both technically feasible and should be demonstrated. However, there is a fundamental distinction between them that may be relevant in meeting the non-proliferation objective (#2 of the first list). Geologic storage creates a Pu mine, and therefore will always be a potential resource for weapons material. So perpetual monitoring will be needed for international confidence. In contrast, the breeder recycle succeeds in burning-up existing Pu, although during recycling there is the possibility of material diversion that will require operational monitoring.

We don't believe that either choice represents an unacceptable economic burden, and this may be diminished with properly focused technology. However, the comparative evaluation of nuclear cycles must factor in the enduring consequences of the differing potential diversion risks to national security, on an intergenerational time scale. Another social cost uncertainty is the future energy resource depletion of a Uranium "once-through" cycle vs. Plutonium recycle in the coming centuries. These are complex topics that await in-depth evaluation.

Our perception of today's spent fuel situation suggests that the world's spent fuel accumulation will create a storage crisis when nuclear plants of the first generation are decommissioned and on-going nuclear capacity grows. The accumulated storage casks in ad-hoc national and plant sites could be a chaotic global mix, leading to unacceptable public risk uncertainties. It has been generally estimated that global electricity production will grow at least 4 times in the coming half century, with most of it in the developing world economies. Nuclear power growth rate can only be a guesstimate, but visible trends in these countries suggest that nuclear will grow as much or more.

For a quantitative perspective (1), assume that by 2060 there may be 3000 plants worldwide (20 yr. doubling time). As a rough "rule-of –thumb", each 1 Gw modern plant produces about 20 metric tons / year of spent fuel metal, of which about 1% is elemental PU. Large storage casks are planned to hold about 10 metric tons of metal, containing about 100 kg of unseparated Pu, a tempting resource for a few weapons. By 2060, the global storage accumulation would probably have reached more than 100,000 casks, with about half in the developing countries. So the diversion of a single cask by a non-weapons state from this stockpile is obviously a cause for concern. It is not the quantity of storage casks that concern us, but rather the likely scatter of non-existent or low quality monitoring. It takes only a few mishandled casks to create health or proliferation risks that extend beyond any one country. We assume this audience is aware of the political pressure to minimize such hazards.

Our judgement is that acceptable national spent fuel programs (e.g. Yucca Mt) will require many decades to become operational, with those of developing countries coming much later. Our IMRSS proposal is to start today to internationalize the interim storage of spent fuel, using existing technologies and operational resources and criteria, in order to provide time for the longer-term alternative disposal technologies to mature, and for a worldwide consensus on standards and monitoring criteria for mutual security to develop. This would also provide time for the parallel diplomatic efforts needed to create a supporting political framework. Obviously, overcoming the innate nationalism of countries will be difficult. There is precedent in the NPT, in the International Atomic Energy Agency (IAEA) and in the World Association of Nuclear Operators (WANO), all diplomacy pioneers. We believe the IMRSS proposal is also achievable due to its real-time benefits to participants. We are optimistic that if a few nuclear nations lead the way, all will eventually join in their own self-interest.

IV. The IMRSS Concept:

The Internationally Monitored Retrievable Storage System (IMRSS) is proposed as a practical interim warehousing method for managing the worldwide spent fuel stream. It is an intermediate step that balances most of today's planning constraints listed above. In its most condensed form, the concept proposes that a new international entity become operationally responsible for the spent fuel exiting the cooling ponds, and provide the transportation required to utilize a small number of surface (or near surface) storage facilities. The IAEA would be responsible for verifying adherence to safeguarding criteria. The economic and political arrangements would be similar to those of an international bank with operating branches worldwide. Each nation would maintain title to its spent fuel, and be able to withdraw it for peaceful purposes (e.g. recycle or burial). Transparency, accountability, and security of the stored material would be openly verifiable by all participants on a real-time basis, so each would know what others are doing. All operations would be on a self-sustaining commercial basis, funded by a megawatt-hour charge (e.g. the US $1/Mwhr) on nuclear power. The international entity would use both multinational and local subcontractors. The substantive details of the proposal have been discussed at three international workshops, and it has been favorably reviewed by SAIC for the US DOD and DOE (2). It was also presented, among other places, at a Seminar at Sarov (Chelyabinsk-70), Russia (3).

The IMRSS proposal recognizes the essentiality of public trust by placing the day-to-day management responsibility for spent fuel in an international institution whose Board of Directors represents all countries that participate in the storage program. The very countries that might face each other in a nuclear conflict would be part of the IMRSS Board, and so will always be aware of their mutual state of spent fuel security in real time. The operational arrangement proposed for IMRSS is thus particularly protective against national diversion.

The question of storage sites is not definitively answered as yet. Based on our informal discussions, we believe these would emerge after a consortium of governments initiates an international approach such as the IMRSS. The political barriers of nationalism and acceptance of interim storage would be removed by such a step. And this would open the door to commercial economic proposals to engage in the business of warehousing spent fuel. We believe competitive site proposals would then be forthcoming.

IMRSS is designed to optimize world-wide acceptance of spent fuel storage based on arrangements that are non-threatening militarily or to public health, are economically self-sustainable, and are foreseeably secure for the next century or longer. It is encouraging that, on a limited scale, BNFL and COGEMA are already offering storage services of this nature.

V. Commentary:

Criticism of all storage proposals arises from a public distrust of the unpredictable urge of governments to obtain plutonium for weapons during a

future wartime fervor. No public wants a nuclear war, but many fear that political demagoguery might escalate into one. Example: the recent India / Pakistan confrontations. We must recognize that any nation with modest technical resources can eventually manufacture weapons material without recourse to civilian nuclear power, if it is dedicated to do so. The technology is in open literature. However, an independent military program is hard to hide. Nationally stored spent fuel represents a clandestine alternative to obtain Pu. With either recycle or burial of spent fuel, what is needed is to make the barriers to diversion so great that military planners avoid the civilian cycle. International management adds another barrier to such diversion, both practical and diplomatic.

The alternative of permanent geologic isolation in underground cavities is intuitively attractive, but, as previously mentioned, the geologic storage cavities are always available as potential mines for extraction of a few spent fuel elements. Aged fuel provides desirable weapons Pu. Thus geologic storage in national repositories is a latent weapons threat for thousands of years. Neighboring countries will always be uncertain of their security, and such suspicion might be the initiating seed for a future arms race. Similarly, any recycle concept under national control has opportunities for diversion at various stages of the separation process. It can be made difficult technically to divert material if the recycle occurs in fast reactors, as limited separation of fission products is adequate for such reactors.

Public opinion-leaders do not trust their own governments to weigh long-term consequences when they adopt convenient short-term fixes for immediate problems. Politicians are suspected of intuitively deferring costly and burdensome management to future generations, as they do now with most of societies' wastes. The public does not expect the weakness of human nature to ever disappear from political processes. So, deferral is always a temptation. Example: US AEC peacetime decisions on the disposal of the waste products from nuclear weapons production during the "cold-war" of 1950-80.

Deferral has been the politically convenient approach to peacetime spent fuel disposal, especially as the flow of spent fuel seemed initially small enough for on-site storage. Causes for this deferral were sometimes economic (to minimize current expenditures and taxes) and sometimes inability to agree on long-term disposal criteria and technologies (e.g. Yucca Mt), aggravated by scientific uncertainties of long-term natural processes. Environmental pressures tend to push for solutions now.

Spent fuel seems to be trapped by such a triumvirate: -- the environmentalists seek to have spent fuel disappear but distrust storage or recycle concepts; countries disagree on eventual future use of spent fuel (permanent disposal vs. recycle of plutonium as a fuel); the technologists are uncertain of the long-term physical performance of alternative disposal schemes. The IMRSS accepts the reality of these positions, and provides a century long care-taking until they are resolved for each nation by more experience, information, and negotiation. The point is that we believe it is better to store securely for the coming decades than

to risk prematurely the implementation today of uncertain back-end cycles, or alternatively to accept the uncertain risks of a "do-nothing" policy. The IMRSS is not being proposed as a solution for perpetuity, or as a means of deferring work on the problem. Its acceptance assumes continuing development of long-term solutions, so that people's trust with regard to both weapons and health is maintained. Its purpose is to buy time and security until the long-term solutions are assured.

The concerns raised by various environmental groups on the need to protect future generations from leaking radioactivity should be seriously addressed technically, and can be. The environmental questions have focused on the quality of the physical containment in geologic repositories, either for "once-through" spent fuel rods or for recycles separated fission products. Containment is being carefully researched currently, but will take many decades to verify in situ. We believe that acceptable burial will eventually be demonstrated with appropriate geochemical sites and containers. We also believe that eventually acceptable recycle will also be demonstrated. We consider that today, the long-term uncertainty of such successful outcomes to be much less than the near-term risk of allowing the stream of spent fuel to spread out in a globally disorderly fashion.

The environmental movement should embrace the IMRSS as a positive step for orderly handling of a growing worldwide problem, which they cannot erase by fiat. The IMRSS offers a positive step to enhancing world peace and public health. For the reasons given above, it removes the option available to individual countries to build a nuclear weapons arsenal by diversion from their civilian nuclear power. It also permits constant monitoring and response to any radioactive leakage. The nuclear age is here and growing. It cannot be turned off. The IMRSS is today a politically and operationally feasible model for spent fuel management. What it needs now is intergovernmental arrangements and negotiation leading to implementation.

The final sentence of the SAIC report (2) states "At the least, the time may well be ripe for the United States, working with other countries, to take the types of actions discussed in this report to explore the concept of IMRSS or an IMRSS-like regime and to determine whether sufficient incentives exist to take this next step toward greater internationalization of nuclear management."

---

* The Association for Studies on the Management of Surplus Nuclear Materials; Vienna, Austria

(1) "A Review of the Economic Potential of Plutonium in Spent Nuclear Fuel"; W. Burch, E. Rodwell, I. Taylor, M. Thompson; Electric Power Research Institute; EPRI TR-106072, February 1996.

(2) “Internationalizing Spent Fuel Storage: Concepts, Issues, and Options”: Lewis A. Dunn & Stephen Carey; Science Applications International Corp (SAIC); Feb. 25, 1998.

(3) “Prudent Management of the Ever Increasing Amounts of Spent Fuel Elements and Plutonium: The Concept of an Internationally Monitored Retrievable Storage System”; Wolf Hafele, Chauncey Starr; International Science and Technology Center (ISTC) Scientific Advisory Committee Seminar on “New Approaches to the Nuclear Fuel Cycles and Related Disposal Schemes, taking into account the existing excessive quantities of weapons grade U and Pu and reactor grade Pu”;
Sarov, Russian Federation, 22-25 June 1998.